

UNDERGROUND COAL FIRES

Emerging as a global threat with significant economic, social and ecological impacts:

1. Introduction – A coal fire is the underground smouldering of a coal seam or coal mine. They are emerging as a global threat with significant economic, social and ecological impacts. There are vast underground coal fires in many locations around the world, consuming millions of tons of coal – creating enormous environmental and human health problems and adding greatly to our climate change burden. Some of these fires have burned for decades – some for centuries.



2. Spontaneous heating of coal - Coal fires can be caused naturally, without human intervention. When old coal workings are exposed to the atmosphere and water for prolonged time, spontaneous combustion of the coal in the old workings occurs and spread into overburden rocks, strata and surface as well. Spontaneous heating in coal mines involves the oxidation of coal deposits. All coals oxidize to some extent when exposed to the atmosphere. Since oxidation is an exothermic reaction between coal and the oxygen component of the atmosphere, heat is constantly being released. This reaction is directly related to temperature; if the heat released by the oxidation reaction is not dissipated, the temperature of the mass increases. In some reactive coals this oxidation can increase to the point that, if remedial control measures are not instituted, the heating can continue and the temperature will rise at an increasing rate until smoldering combustion occurs.



Brown coal or lignite may start burning at 40 °C to 60 °C whereas anthracite will start at 140 °C. The smouldering will usually start several decimetres below the surface in a depth where the permeability of the coal allows the access of enough air but the air flow is slow enough to not extract the produced heat by convection. Due to the low heat conductance coefficient of coal heat extraction by conduction alone is not sufficient. Spontaneous ignition needs time. How much depends on many factors, as temperature, volume, particle size. Finally the time to ignition is another parameter to describe the addition of coal to burn. For larger volumes the temperature needed is smaller but the time needed larger. Normally it will take months before coal will start smouldering.

coalfire_2If coal seams outcrop to the surface, air has access for long times. At those location seams will start to burn spontaneous and continue burning for decades. Globally at least 20 to 30 million tons are burned by those fires. The coal being made inaccessible for further mining is about the times more.

3. Global coal seam fires – Coal fires are reported from coal mining districts all over the world. The most important are the following:

* India – Besides the areas of Ranigani and Singareni coal seam fires rage in Jharia. In an area of about 700 sq km more than 160 fires are burning. As a consequence of the fires hang slides, sink holes and subsidence is reported. As this area is densely populated pollution is severe. Coal mining supports the development of fires it give air better access. On the other hand coal fires limit the mining and may even stop it. It is estimated that in India 70% of the fires are due to mining.

* USA – Many coal mining areas in the USA suffer from spontaneous coal seam fires. The Federal Office of Surface Mining (OSM) provides a data base that lists 150 fire zones (1999). Those are not only in Kentucky, Pennsylvania and West Virginia in the east of the Appalachian-coal district, but also in Colorado and the Rocky Mountains.

In Pennsylvania 45 fire zones are reported. The most known is Centralia Mine, in the anthracite- coal area of Columbia County. This fire burn since 1962 and develop below the city. There was some effort to extinguishing the fires but finally the city was lost. coalfire_outdoor fire

In Colorado some spontaneous coal fires are due to annual changes in the water table. Those changes may rise water temperatures by 30 °C, and thus start the self ignition process.

* Germany – In Planitz near Zwickau a coal seam burned from 1476 and was finally not extinguished before 1860. Ernst August Geitner started in 1479 a green house with tropical plants above the known Planitz fire zone and was possible the first in using energy from coal fires commercially. In Dudweiler (Saar) 1668 a coal seam started to burn and developed to a tourist attraction named 'Burning Mountain', even visited and described by Goethe. Equally known is the so called 'Smelling Wall' at the east slopes of 'Hohe Meissner', where after closing the lignite mining some seams started burning centuries ago and exhaust gases escaped to the surface causing the 'smell'. Today most of the coal fires here are due to unwanted ventilation in abandoned parts of the mines. Those measures were principally successful and heavy mine fires with loss of human life did not occur.



* Rest of Europe and Russia – Reported coal fires in those areas are decreasing parallel to the decrease of mining activity in general. Some burning is reported from Poland, Czech Republic and Ukraine. In Ukraine 2.000 million tons are laying on dumps and 74 fire zones are reported. In Kosovo (Serbia) and Bosnia-Herzegovina coal seams are burning close to open pit or deep mining.

* Africa – The big coal mining districts of Africa are in the south of the continent, in South Africa, Zimbabwe, Botswana, Mozambique und Zambia. Coal fires are reported from all that regions.

* China – China is the largest coal producer (and consumer) world wide. It produces about 1.8 billion tons in 2006. As a result coal fires are a severe problem in China. It is estimated that 10-20 million tons are directly burned by coal seam fires and 100-200 million tons of coal are lost for the mining industry.

* Other areas – The Indonesian Forest Fire Prevention and Control Project (FFPCP) reported coal fires burning more then four years. Two new fires were reported from the region Suban Jeriji. Coal fires were also reported from Venezuela, but no detailed information is available.



4. Dangers / hazards these coal fires pose and its environmental impacts - Coal fires start naturally or as a result of human activities or more often due to a combination of both factors. The phenomenon of spontaneous combustion is the main natural cause of coal fires, though lightening, forest/bush fires or frictional heat generated during earth movements could also start coal fires. Among human causes are accidents, negligent acts, domestic fires, lighting fires in abandoned underground mines for heating or distilling alcohol etc. It is worth noting that mine refuse dumps and fine carbonaceous material in the proximity of mining sites is very prone to spontaneous combustion. More often it is this loose material which first catches fire which subsequently spreads to the coal seams. Fires also travel from one coal seam to the neighbouring coal seam and from one mine to another.

Besides burning away the important non renewal energy resource and causing financial losses, these fires hinder economic exploitation of coal, pose danger to man and machine, raise the temperature of the area, engulf surface features such as buildings, transportation network etc., and when present in underground are a cause of land subsidence. The pollution caused by these fires affects all the three environmental amenities, viz. air, water and land. Smoke emanating from these fires contain poisonous and obnoxious smelling gasses such as oxides and dioxides of carbon, nitrogen and sulphur which along with particulate matter are the cause of several lung and and skin diseases.



Burning coal is a leading cause of smog, acid rain, global warming, and air toxics. Damage from acid rain has been widespread in eastern North America and throughout Europe, and in Japan, China, and Southeast Asia. Acid rain leaches nutrients from soils, slows the growth of trees, and makes lakes uninhabitable for fish and other wildlife. In cities, acid pollutants corrode almost everything they touch, accelerating natural wear and tear on structures such as buildings and statues. Acids combine with other chemicals to form urban smog, which attacks the lungs, causing illness and premature deaths.

When the coal burns, the earth above and surrounding can effectively heat-up, destroying CO₂ mitigating plants and biodiversity. Additionally, the great caverns created when coal seams smolder themselves out of existence underground can cause dangerous land subsidence.



5. Prevention of coal seam fires – Avoiding fires or fire prevention is therefore primarily the responsibility of the mining industry. The final aim is ‘mining without fires’. Many suggestions have been made, as change of the mining technology or mining methods, alternative mine lay out, different ventilation methods. Extremely important is the complete extraction of coal and to avoid leaving back coal or coal dust in the goafs. Finally mine closure is an issue and should be made strictly along the regulations.

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